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THE HOST SPECIFICITY AND BIOLOGY OF *ARISTOTELIA IVAE* BUSCK (GELECHIIDAE) AND *LORITA BACCHARIVORA* POGUE (TORTRICIDAE), TWO MICROLEPIDOPTERA SELECTED AS BIOLOGICAL CONTROL AGENTS FOR *BACCHARIS HALIMIFOLIA* (ASTERACEAE) IN AUSTRALIA

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Abstract.—The host specificities and biologies of two microlepidoptera, *Aristotelia ivae* Busck (Gelechiidae) and *Lorita baccharivora* Pogue (Tortricidae) were determined prior to their utilization for the biological control of the noxious weed *Baccharis halimifolia*. Both species were multivoltine foliage feeders with generation times of approximately 6 weeks. Host specificity was assessed by the ovipositional preference and ability of larvae to feed on 65 plant species. *Aristotelia ivae* oviposited all but 2 eggs on *B. halimifolia* and larvae developed only on this plant. *Lorita baccharivora* oviposited all but two eggs on *B. halimifolia* and larvae also only developed on this plant. It was concluded that both species were host specific to *Baccharis*. Permission for their introduction into Australia was obtained. Both species were released in Australia and establishment of *A. ivae* has been confirmed.

Key Words: *Aristotelia, Lorita, Baccharis*, biological control, host specificity

Following its introduction into Queensland, Australia, before 1900, the North American shrub *Baccharis halimifolia* L. (Asteraceae: Astereae: Baccharineae) became a serious weed in SE Queensland and NE New South Wales by invading pastures and land cleared for reforestation. The plant was declared noxious in 1951 and subsequently a biological control program to find and introduce suitable host specific insects from the New World was implemented. This program consisted, in essence, of intensively surveying appropriate areas, selecting stenophagous species from available knowledge, testing the host range of these species experimentally and, if their host range were limited to *Baccharis*, mass rearing and releasing the insects in Australia.

Two foliage feeding microlepidoptera *Aristotelia ivae* Busck (Gelechiidae) and *Lorita baccharivora* Pogue (Tortricidae) were found infesting *B. halimifolia* along the eastern seaboard of the United States (Palmer and Bennett 1988). Literature reviews and consultations with relevant experts indicated that they might be host specific to *Baccharis*. Furthermore their occurrence in Florida was thought advantageous as this state has a climatic similarity to Queensland.

The genus *Aristotelia* Huebner contains 39 species none of which is considered an agricultural pest (Arnett 1985). Busck (1904) described both the moth and larva of *A. ivae* from material collected at Palm Beach, Florida and reared by H. Dyar in 1900. Two

other species have been recorded from *Baccharis*. Tilden (1951) described the life history of *A. argentifera* Busck which has *B. pilularis* DC. and the closely related *Ericameria ericoides* (Lessing) as hosts. Recently we found a very similar undescribed species (R. Hodges pers. com.) on *B. pilularis* that might also be host specific to *Baccharis*.

The genus *Lorita* Busck, recently revised by Pogue (1988), contains two species, *L. baccharivora* and *L. scarificata* (Meyrick). *L. scarificata* is a widely distributed, polyphagous species that is a pest of bell peppers, *Capsicum annuum* L. (Solanaceae) (Pogue 1988).

This paper describes the host specificity studies undertaken to ascertain the host range of these insects. Before permission could be sought to introduce them into Australia, it was necessary to demonstrate that they were specific to *Baccharis* and that no native or commercial plant species in Australia would be endangered. In the course of these studies the biologies of the insects were observed and these are also reported.

Biology

The following descriptions are based on our laboratory and field observations of the various life stages.

Aristotelia ivae.—Eggs which are 25 mm in length, oval in shape and greenish-white with characteristic orange markings in color, were oviposited in leaf axils, furrows of young stems or the midribs of leaves. Eclosion occurred in 5 to 10 days and larvae moved to young growing tips to feed beneath a loose silken webbing. Five larval stadia were observed by the finding of cast head capsules. The first four stadia were of about 4 days duration. The final stadium was 9 days including a prepupal period of 3 days. Pupation occurred in leaf litter surrounding the plant and adult eclosion occurred after 10 to 14 days. The life cycle was completed in about 6 weeks.

Lorita baccharivora.—Eggs are round and slightly flattened, whitish in color and translucent. They were oviposited along the midrib on the upper surface of fully expanded leaves where they were relatively easily discernible. Eclosion occurred in 10 to 20 days. Neonate larvae were active and fed on nearby leaves. After 2 to 3 days larvae moved to growing tips where they fused young leaves together with silk to form a tube. The larva lived within this tube but left it to feed on adjacent leaves. The leaves and the growing point in the tube usually died so that further growth of the stem was arrested. Pupation occurred within the tube and the life cycle was completed in 4 to 6 weeks.

Hosts, Distribution and Phenology

Aristotelia ivae is found throughout much of the range of *B. halimifolia* and has been collected from Maryland (Kraft and Denno 1982) to Texas where it has also been found on *B. neglecta* Britton (Palmer 1987). Except for one series, all specimens have been collected from *Baccharis* sp. Busck (1904) gave *Iva frutescens* L. as the host for the type series he described but we believe that the host was misidentified (cf. Palmer and Diatloff 1987).

A. ivae is a multivoltine species. Although more abundant in spring and early summer, it was found throughout most of the year in Florida. Occasionally damage to the plant was extensive with the leaves of the plant having a characteristic skeletonised appearance. Defoliation usually proved to be only a temporary setback for the plant which invariably recovered. High rates (>50%) of parasitism were observed and a species of *Apanteles* sp. (Braconidae) was collected from larvae.

Lorita baccharivora has been collected in Florida and Texas (Pogue 1988). In Florida we collected it from Gainesville to the Florida Keys and found it almost throughout the year. While it is an abundant, widespread species in Florida it is only rarely encountered in Texas. Damage to the plant

Table 1. Plant species against which *A. ivae* and *L. baccharivora* were tested to obtain permission for their introduction into Australia.

Apiaceae: *Daucus carota* L.; *Pastinaca sativa* L.
Anacardiaceae: *Mangifera indica* L.
Asteraceae: *Baccharis halimifolia* L.; *Carthamus tinctorius* L.; *Chrysanthemum* sp.; *Dahlia* sp.; *Helianthus annuus* L.; *Lactuca sativa* L.
Brassicaceae: *Brassica oleraceae* (L.) Alef.; *Brassica rapa* L.
Bromeliaceae: *Ananas comosus* (L.) Merr.
Caricaceae: *Carica papaya* L.
Chenopodiaceae: *Beta vulgaris* L.
Convolvulaceae: *Ipomoea batatas* (L.) Lam.
Cucurbitaceae: *Cucumis melo* L.; *Cucumis sativus* L.; *Curcubita maxima* Duch.
Fabaceae: *Arachis hypogaea* L.; *Centrosema pubescens* Benth.; *Desmodium canum* (Gmel.); *Glycine wightii* (R. Grah. ex Wight & Arn.) Verdc.; *Glycine max* L. Merr.; *Medicago sativa* L.; *Phaseolus atropurpureus* DC.; *Phaseolus vulgaris* L.; *Pisum sativum* L.; *Stizolobium* sp.; *Stylosanthes gracilis*; *Trifolium repens* L.; *Vigna catjang* V.
Linaceae: *Linum usitatissimum* L.
Malvaceae: *Gossypium hirsutum* L.
Mimosaceae: *Leucaena leucocephala* (Lam.) de Wit.
Musaceae: *Musa sapientum* M.
Passifloraceae: *Passiflora edulis* Sims
Pinaceae: *Pinus radiata* D. Don.; *Pinus taeda* L.
Poaceae: *Avena sativa* L.; *Digitaria decumbens* Stent.; *Panicum maximum* Jacq.; *Paspalum dilatatum* Poir.; *Pennisetum clandestinum* Chiov.; *Saccharum officinarum* L.; *Sorghum vulgare* L.; *Triticum aestivum* L.; *Zea mays* L.
Proteaceae: *Macadamia integrifolia* Maid & Betche
Rosaceae: *Fragaria vesca* L.; *Malus sylvestris* Mill.; *Prunus domestica* L.; *Prunus persica* (L.) Batch.; *Pyrus communis* L.; *Rosa* sp.
Rutaceae: *Citrus limon* (L.) Burm. F.; *Citrus paradisi* Macfady.; *Citrus reticulata* Blanco; *Citrus sinsensis* (L.)
Sapindaceae: *Litchi chinensis* Sonn.
Solanaceae: *Capsicum annuum* L.; *Lycopersicum esculentum* Miller; *Nicotiana tabacum* L.; *Solanum tuberosum* L.
Vitaceae: *Vitis vinifera* L.
Zingiberaceae: *Zingiber officinale* Roscoe.

was significant when populations were high, especially on plants under 2 m high. High rates (>50%) of parasitism were observed and *Apanteles* sp. (Braconidae) and *Macrocentrus* sp. (Braconidae) emerged from larvae. The only known host plant for this species is *B. halimifolia*.

Host Specificity

The host specificity testing was conducted at the Archbold Experimental Station at Lake Placid, Florida in 1968. The same experimental design was used for both species although testing was not done concurrently. The ovipositional preference of the moths and the food preference of larvae were tested against a list of plants suggested by the Commonwealth Department of Health (Table 1).

Ovipositional preference was determined by placing cuttings of young actively growing foliage from all of the test plants (Table 1) in a 40 × 36 × 30 cm glass-sided cage. The cuttings were held in glass vials with water. Twenty unsexed moths were placed in the cage with a honey-water mixture. When the *B. halimifolia* was obviously infested, all the cuttings were carefully observed and all eggs counted. Any infested cuttings were kept for further observations on the hatching and survival of larvae. The experiments were replicated twice.

Food preference was determined by placing five field collected, partly grown larvae on each of the 65 test plants, held in plastic pots. The plants were carefully observed daily for 10 days and any larvae noted. These experiments were also replicated twice.

Aristotelia ivae.—Heavy oviposition occurred on *B. halimifolia* within 3–5 days and the resulting larvae developed rapidly. Two eggs were found on one cutting of *Leucaena leucocephala* (Lam.) de Wit. but eggs were not found on any other plant. These two eggs hatched but the neonate larvae did not feed and had disappeared by the next day. When the field collected larvae were placed on test plants they left all but the *B. halimifolia* plants within 2 days. Some wandered away and died while others moved to the *B. halimifolia* plants and commenced feeding. No feeding was attempted on any plant other than *B. halimifolia*.

Lorita baccharivora.—Heavy oviposition occurred on *B. halimifolia* cuttings within 3 to 7 days. Resulting larvae fed on the expanded leaves for 2–3 days before moving to the growing tips to form silken tubes.

Two eggs were also found on one cutting of *Prunus persica* (L.) Batch but eggs were not found on any other plant. These two eggs hatched but the resulting larvae did not attempt to feed. When field collected larvae were placed on test plants they left all plants other than *B. halimifolia* within 3 days. Some wandered away and were lost but most moved onto the *B. halimifolia* plants where they occupied almost every available terminal. Neither feeding nor fusing of leaves to form a tube was attempted on any plant other than *B. halimifolia*.

In both cases, the tests indicated that the insects were sufficiently specific to release in Australia. Both insects exhibited a strong host finding mechanism in that virtually all their eggs were laid on the *Baccharis* cuttings. This evidence is particularly significant as, under cage conditions, many species of moths oviposit on plants and objects that would not be utilised under natural conditions. The subsequent feeding tests confirmed the narrow host range indicated by the oviposition tests. Larvae could survive on only *B. halimifolia* of the 65 plant species tested.

Release in Australia

Permission was obtained to import the insects into Australia. On arrival, both species were required to be bred through one generation in quarantine facilities to ensure that all parasites were eliminated. They were then mass reared in non-quarantine facilities to produce sufficient numbers for field release.

Aristotelia ivae was introduced in southeastern Queensland in 1969 when approximately 25,000 moths were released at five locations. It readily established in this area; at one site it spread out over 40 sq. k within 2 years of release. By 1974 it was found throughout the range of *B. halimifolia* in Australia. Although there have been localized areas where high populations have caused significant damage on smaller plants, generally it has not occurred in sufficient densities to control the weed.

Lorita baccharivora was imported into Australia in 1969 but was not then successfully reared. Following further importations in 1984, it was successfully mass reared at the Alan Fletcher Research Station and released at various locations in southeastern Queensland in 1986. Moths have not yet been recovered from the field so establishment has not been confirmed. Further releases were made until the end of 1987.

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